

Operating Instructions

AK 400 PECVD System for Silicon Nitride and Silicon Carbide Layers

PECVD (Plasma Enhanced Chemical
Vapour Deposition) System for Silicon
Nitride and Silicon Carbide Coating

Customer:
The Australian National University
Canberra
Australia

Project:
23131

Manufacturer:
Roth & Rau Oberflächentechnik AG
Gewerbering 3
OT Wüstenbrand
D-09337 Hohenstein - Ernstthal
Tel: +49-3723 – 49880
Fax: +49- 3723 – 498825
E-mail: info@roth-rau.de
Web: www.roth-rau.de

TABLE OF CONTENTS

1	INTRODUCTION	3
1.1	GENERAL DESCRIPTION	3
1.2	APPLICABILITY	3
1.3	USE FOR THE INTENDED PURPOSE	4
2	SAFETY	5
2.1	OVERVIEW	5
2.2	GENERAL SAFETY REGULATIONS	5
2.3	SAFETY CONCEPT OF THE SYSTEM	7
3	DESCRIPTION OF THE CONSTRUCTIONAL DESIGN	8
3.1	RECIPIENT	8
3.2	LOAD LOCK	8
3.3	VACUUM SYSTEM	8
3.4	VACUUM GAUGES	9
3.5	PLASMA SOURCE AND SUBSTRATE HOLDER	9
3.6	GAS DOSING SYSTEM	10
3.7	ELECTRICAL EQUIPMENT AND CONTROL	10
3.8	SAFETY DEVICES	11
4	INSTALLATION	13
4.1	ELECTRICAL CONNECTION	13
4.2	WATER SUPPLY	13
4.3	COMPRESSED AIR CONNECTION	14
4.4	GAS CONNECTIONS	14
5	OPERATION	15
5.1	START	15
5.2	SOFTWARE DESCRIPTION	15
5.3	SHUTDOWN	15
6	SERVICES	17
6.1	MAINTENANCE	17
6.2	SPARE PARTS	17
6.3	REPAIR / REPLACEMENT	17
6.4	TRAINING	18
7	APPENDIX	19
7.1	DIAGRAM OF THE VACUUM SYSTEM	19
7.2	DIAGRAM OF THE GAS DOSING SYSTEM	20
7.3	DIAGRAM OF THE WATER SYSTEM	21
7.4	INTERLOCK DESCRIPTION	21
7.5	TECHNICAL DATA	23
7.6	OPERATING INSTRUCTIONS FOR INDIVIDUAL COMPONENTS	24

1 INTRODUCTION

1.1 General Description

AK 400 PECVD systems are systems which may be flexibly equipped plasma-supported CVD coating processes suitable for R&D and small-lot production.

The system described here has a cuboid recipient that is provided with several flanges. Its dimensions are as follows: Front to back: 540 mm, width: 580 mm and height: 350 mm. All flanges are metal-sealed CF flanges. The pumping system, plasma source, substrate holder system, gas dosing system and heating system are connected with the recipient. The chamber is made of chemically resistant high-grade special steel with glass bead blasted surfaces in welded design. The chamber's front door is used for loading the system. Operation of this door is facilitated by gas springs. The rear flange may be opened to perform operational and servicing tasks which may be necessary. At least two persons are necessary to do this, or lifting gear has to be used. The system further includes a frame on which the recipient, the lock and the gas box are mounted. The electrical equipment and control unit are integrated into a separate 19" rack cabinet.

Flange configurations make the system highly flexible for the connection of further components.

Pumps are configured for the respective processes in the coating chamber and for the process requirements concerned. A Roots pump and a rotary pump are used here.

The gas dosing system, substrate heater and substrate holder have been developed for the specific processes concerned. The only materials used are chemically resistant high-grade special steel, ceramics and graphite.

An LPS 1.0 linear microwave plasma source with quartz tube applicator is used as plasma source. MW coupling is performed on both sides. A multipole magnetic field generated by permanent magnets may serve as plasma stabiliser.

1.2 Applicability

The operating instructions for the AK 400 system are a customer document by *Roth & Rau Oberflächentechnik AG*. They contain a description of the system and its functions, and they provide essential information for using the system.

Operating instructions of individual components are a part of the document as a whole. They listed in the last section.

The description of the system is made in accordance with the EC "Machinery" Directive (98/37/EEC). This involves taking into account the increased need for information with regard to function and new safety

requirements. The information provided in the operating instructions for the AK 400 system applies to the system's latest development status.

This documentation shall remain applicable, provided that the customer refrains from effecting any change of the system whatsoever. The customer will be furnished with relevant documentation if the manufacturer deems it necessary to amend these instructions.

1.3 Use for the intended purpose

Use for the intended purpose of the plasma deposition system described herein refers solely to high vacuum experiments for the coating of substrate surfaces using PECVD processes in the areas of R&D and production.

Using the system for the intended purpose also requires reading these operating instructions and complying with them before the start-up of the system by the user.

2 SAFETY

2.1 Overview

This section provides an overview of the safety concept of the AK 400 PECVD high vacuum system under consideration of the requirements pursuant to the EC Directive: "Machinery" (98/37/EEC).

IMPORTANT:

All persons involved in the installation, operation or maintenance of the AK 400 PECVD system are required to have read and understood relevant parts of the operating instructions, in particular Section 2: "Safety" as well as all safety-related instructions in the other sections (e.g. "Safety devices", etc.). The company operating the system is advised to demand written confirmation thereof accordingly.

2.2 General safety regulations

In addition to the safety-related instructions provided in relevant sections, follow the regulations set forth below.

The AK 400 PECVD system has been constructed using the best available technology and is considered to be safe to operate. However, if it is used by unskilled staff or in case of failure to use it properly or for its intended purpose, certain risks may be posed by this system.

1. AK 400 PECVD systems have been solely designed for adequate experiments and operations in the areas of R&D and production under vacuum conditions. No other applications are available unless specifically agreed. Any use going beyond this information shall be deemed as failing to comply with the system's intended purpose. The manufacturer shall not be liable for any personal injury or damage whatsoever.
2. Using the system for its intended purpose also includes complying with the rules for installation, start-up, operation and maintenance stipulated by the manufacturer.
3. The AK 400 PECVD system may only be operated, maintained and serviced by duly authorised, skilled and instructed staff. Such staff is required to have been given special instructions on all risks that may occur.
4. Responsibilities with regard to installation, start-up, operation and maintenance shall be clearly defined and complied with to prevent any situation where it may be unclear who is responsible with regard to safety.

5. The switch-off procedures described in the operating instructions shall be observed for all work concerning installation, start-up, operation and maintenance.
6. It is imperative to refrain from any operation that may affect the operator's safety or the safety of the AK 400 PECVD system.
7. The operator shall be among those responsible for ensuring that only authorised persons work on the system, and that they follow operating algorithms only. This particularly applies to children.
8. The operator shall report any occurring change of the AK 400 PECVD system that may affect the system's safety to the company operating it promptly.
9. The company operating the system shall not operate the AK PECVD system unless it is in perfect condition.
10. The company operating the system shall be required to ensure proper housekeeping for the system by issuing instructions and performing checks accordingly.
11. Arbitrary reconstruction and changes affecting safety shall not be permitted. Any change of the operating software of this system shall not be permitted as well.
12. Disconnect the system from power before carrying out any installation or maintenance work.
13. Before restarting the system after repairs, make sure that all protective devices are in place and that they are functioning properly (e.g. safety circuits).
14. Do not remove protective devices unless the system has come to a standstill and unless it has been disconnected from power.
15. The AK 400 PECVD system may only be transported completely using a fork lift truck, low lift platform truck or lifting crane.
16. Safety precautions used shall be tested following electrical installation and repair work.
(e.g. leakage resistance higher than 1 MΩ).
17. In any case, relevant national and local safety and accident prevention regulations shall apply to the operation of the system.
18. Cooling water hoses and power cables shall be fed to the AK 400 PECVD system separately from the connection point provided by the customer. They shall not interfere with any electrical equipment.

2.3 Safety concept of the system

2.3.1 Protection against personal injury

All protective covers against high voltage and RF are locked using tools.

All connections and the interior space of the recipient have been designed to be RF proof.

High-voltage current parts are arranged apart from control units.

The safety circuits listed below provide protection against risks of personal injury posed by high voltage, electromagnetic radiation and emission of hazardous substances:

- Personal safety circuits (see section "Interlock description" in the Appendix)
- Emergency shutdown circuit

The company operating the system shall be responsible for implementing any additional safety precautions !

2.3.2 Protection against property damage

Unacceptable operating states resulting from incorrect operation, faults relating to the supply of media or system defects are prevented using hardwired interlocks and suitable sensors. The system software also monitors all the system's operating states and shuts off components and subassemblies if an error occurs, and an error message is displayed on the screen accordingly.

A protective cut-out in case of loss of power or undervoltage will cause the master switch to open, preventing any uncontrolled restarting.

IMPORTANT

When installing further system components, the customer shall comply with relevant regulations for avoiding unacceptable operating states, and he shall obtain the manufacturer's specific approval !

3 DESCRIPTION OF THE CONSTRUCTIONAL DESIGN

3.1 Recipient

Made of high-grade special steel, the coolable recipient of the system has the following inside dimensions: L x W x H = 400 x 500 x 250 mm. It is installed in a horizontal position. There is an inspection glass in the rectangular chamber door, making it possible to observe the process visually. The chamber door at the rear has been provided for purposes of installation and maintenance only. The substrate to be coated is inserted through the front door and placed on the substrate carrier plate of the substrate holder.

The recipient has been mounted on a sectional frame made of high-grade special steel.

The plasma source, the pumping system with slide valves, the substrate holder, pressure gauges, gas inlets, feedthroughs and other components are mounted to the chamber walls using different flanges DN 16CF to DN 160CF. The distributor of water circuits for temperature equalisation is installed in the system rack.

For a functional diagram and illustrations showing all subassemblies and components please refer to the Appendix.

3.2 Load lock

It is possible to install a Load Lock system.

3.3 Vacuum system

3.3.1 Pumping unit and pressure control

Essentially, the vacuum pumping unit consists of:

Components	Recipient
Roots pump unit	WOD 412 BC (WKP 500)
Pumping unit (rotary pump)	WOD 412 BC (DUO 65 C)
Suction control valve	Butterfly valve DN 100 CF
Vacuum valves	Angle valve DN 100 ISO-KF
Oil mist filter	ONF 65

(see also the "Diagram of the system" in the Appendix)

The Roots pump unit is suitable for use with corrosive gas. It is filled with Fomblin lubricant. Follow the operating instructions for the components concerned when adding and checking lubricants.

For further information on the function and maintenance of pumps please also refer to the operating instructions provided separately.

3.4 Vacuum gauges

The measured parameters of vacuum gauges are analysed using a PC interface card and displayed.

Recipient:

- Compact FullRange™ Gauge PKR 251 (metal-sealed)

Measuring range: 1000 mbar to 5×10^{-9} mbar

- Absolute pressure sensor MKS Baratron® Type 127

Measuring range: 1 mbar to 10^{-4} mbar

(Description: see relevant operating instructions)

3.5 Plasma source and substrate holder

An LPS 1.0 linear microwave plasma source with quartz tube applicator and microwave coupling on both sides is arranged horizontally in the recipient as process source. In addition to the two quartz glass tubes the source includes a shield on the quartz glass side facing away from the substrate and a multipole magnetic field (permanent magnets) whose purpose is to improve plasma stability, in particular for silicon processes. Two gas showers for process gas intake, one leading into the source and the second one over the substrate table, ensure that gas distribution within the plasma space optimises the process. The plasma source is powered by two magnetron heads (2.46 GHz, 2000 W) with circulator and 3-rod tuner. The microwave generators are supplied with power from two units of 2000 W, 3.5 kV in the rack cabinet.

The substrate holder is made of high-grade special steel, ceramics and graphite. It may be heated up to 800°C. The substrate carrier plate is heated using two graphite heating elements having the shape of wave patterns. This rear side radiation heater is necessary because the substrate carrier plate lies on RF potential. The heater includes a power supply unit with PID temperature controller, power controller and a transformer with output voltages up to 2 x 25 V, 50 Hz. Temperature is measured using a Type K thermocouple at a reference measuring location just below the substrate carrier plate. The substrate holder is RF bias capable up to 600 W / 500 V. Its substrate take-up surface is 300 mm x 200 mm, and it is installed as a subassembly inside the recipient. In order to ensure a stable and DC bias controlled plasma process, an automatic matchbox with DC bias display has

been firmly flange-mounted at the bottom of the recipient after a water-cooled RF feedthrough. An RF generator, 13.56 MHz, 600 W, arranged in the rack cabinet of the system provides the substrate holder with RF.

The dark space shield consists of a carrier made of high-grade special steel. It is water-cooled. The substrate holder represents the central processing station.

For an illustration of the constructional design please refer to the assembly drawing in the Appendix.

The substrate holder is supplied as a completely assembled component, adjusted to suit the customer's specific needs.

Any other fine tuning and specific adjustments required by the customer should be performed solely by *Roth & Rau Oberflächentechnik AG* service staff, by service staff of third-party companies that have been duly authorised by our company to perform such servicing, and by such staff of the company operating the system that has been duly trained and qualified by our company.

3.6 Gas dosing system

The four-channel gas dosing system allows a defined inlet of inert (one channel) and reactive gases (three channels) via MFCs. Reactive gas channels may be purged using nitrogen through another gas inlet (see "Diagram of the gas dosing system" in the Appendix). The pneumatic diaphragm valves used are suitable for applications with high purity gas and UHV, and they are triggered via a pneumatic valve island.

Gas valves and MFCs are controlled using the PC control system.

In order to meet the requirements of safety and observe the purity of the gas used, only gas pipes made of chemically resistant high-grade special steel having a surface roughness of $R_a \leq 1\mu\text{m}$ and VCR[®] high-grade special steel screw connections are used.

3.7 Electrical equipment and control

The entire system is controlled using an industrial PC, installed into a 19" rack cabinet by 40HE, which contains the entire electrical supply system. It further includes the system and application software based on Windows[®] NT, with manual, automatic and service mode. The rack cabinet also includes all other control and power supply devices.

3.8 Safety devices

3.8.1 Vacuum controller

The vacuum controller for the recipient is a pressure-sensitive switch having two switching points (atmosphere and vacuum). Switching points are set depending on process and vacuum parameters.

In order to ensure that the system is safe to operate, this controller is a part of the safety chain (see the interlock description in the Appendix).

3.8.2 Emergency shutdown switch and master switch

Arranged at the rear of the system cabinet is the master switch of the entire system. When it is operated, the system is either turned on or disconnected from power. The master switch is marked in red.

The snap-in emergency shutdown button (also marked in red) is arranged at a height that is easy to reach for the operator, at the front of the rack cabinet. To operate the emergency shutdown switch simply push in the marked button. Whenever an emergency shutdown operation is set off, the entire system is disconnected from the mains via the master switch. To re-connect the system after operating the switch, unlock emergency shutdown switch by turning to the left. In case of an emergency shutdown the master switch takes an intermediate position, and it has to be fully switched off before it may be re-connected.

3.8.3 Process switch

The process switch is an internal protective switch to prevent personal injury and damage to the system by incorrect operation (door, gas inlet, excess temperature) or failure of system components (pumps, valves, seal gas, vacuum, PC). The protective switch is activated and deactivated through the software when required process conditions have been reached. The switch is opened irrespective of the PC when a hardware safety chain into which several safety-relevant contacts have been integrated is disconnected. (see section 8.3, "Interlock description")

3.8.4 Specific safety regulations for plasma systems

Additional safety regulations as detailed below apply to the AK 400 PECVD plasma system:

The system may only be operated by duly qualified skilled persons or by specifically instructed staff. Specified operating parameter fields have to be observed.

Any assembly, removal and maintenance work may only be performed on the system while it is voltage-free.

Disconnect system from mains before removing any protective covers or enclosures.

Before restarting, re-install all protective covers and enclosures that were removed earlier.

DANGER! HIGH VOLTAGE!

When using reactive gases as working gases, observe the generally applicable guidelines as well as the laws and regulations pertaining to the use of such gases while installing gas feeder pipes and during the process. (see also section 4.4, "Gas connections")

Before carrying out any assembly, removal and maintenance work, make sure that, if radioactive, reactive or toxic process substances are used, the components and surfaces which have come into contact with such substances are decontaminated. When despatching parts and components be sure that the form

"Declaration about Contamination"

is completed.

4 INSTALLATION

Install the system horizontally on a plane, vibration-free surface.

The pumping unit is decoupled elastically, and it is installed in an oil pan made of high-grade special steel, which is capable of taking up all of the pumping unit's oil in case of an emergency.

The connection (DN 40 KF) on the exhaust side of the rotary pump should be connected to an active exhaust gas ventilator or exhaust gas cleaner. Taking into consideration the types of gas used it is also possible to use hose connections. In this respect, the length and cross-section of the exhaust line have to be dimensioned in such a manner as to prevent any dynamic pressure from building up within the line. The operating instructions for the vacuum pumps have to be observed.

4.1 Electrical connection

It is imperative to ensure that earthing with a conductor cross-sectional area of at least 16 mm^2 has been provided by the customer before the start-up of the system (copper earth wire).

The system has been designed for three-phase current, 400 V, 50 Hz, with neutral conductor and protective earthing. Connected wattage is approx. 20 kW, depending on the equipment used. Mains connection is provided by a CEE plug 32 A / 400 V or a fixed connection with an appropriate connected load. Before connection to the mains make sure that the mains voltage matches the voltage indicated on the nameplate.

4.2 Water supply

The cooling water system of this system has been installed and is ready for operation. It is provided with one central connection point for the inlet pipe and one for the outlet pipe, respectively. They have to be connected with the appropriate house service connections.

Flow controllers have been integrated into the interlock chain in order to ensure the safety of operation. If actual water quantity is lower than the set quantity, the contact will open, discontinuing the process.

There are four separate water circuits. The quantity of water required for the entire system is approx. 840 l/hour.

Water primary pressure should be approximately 4 bar. When running back, the cooling water should be in a depressurised state.

4.3 Compressed air connection

The entire compressed air system has been installed and is ready for operation. To achieve a better safety of operation and a longer service life of pneumatic elements, use only filtered and oil-free compressed air at 5 bar minimum, preferably 6 bar. Observe compressed air quality standards in accordance with ISO 8573.1 Class 4 (provide maintenance unit where appropriate).

The compressed air connection is designed as a 6 mm hose connection. Compressed air is controlled, distributed and monitored within the system.

4.4 Gas connections

The system is provided with a four-channel gas dosing system. Connections are executed as 4VCR® and Swagelock® 6mm.

To ensure the safety of operation, primary pressure of mass flow controllers may not exceed 10 bar, and it should be at least 1.5 bar. (See MFC operating instructions). Recommended primary pressure for a high control precision is 2 to 3 bar.

It is necessary for the safe operation of the system to add nitrogen having a purity of at least 5.0 at a primary pressure of 3 bar minimum. Silane / ammonia processes may require a consumption of up to 20 l/min. The nitrogen connection is designed as a separate connection. Using pressure controllers, control valves and sensors, it is used in order to vent the boiler, purge the gas lines, and as seal gas simultaneously diluting process waste gas.

The rules and regulations listed below have to be observed for the pre-installation of the process gas feeder carried out by the customer and for the storage of these gases.

- | | |
|-----------|---|
| TRG 280: | Technical rules for pressurised gases - Operation of pressurised gas vessels |
| TRGS 220: | Technical rules for hazardous materials - Safety data sheet for hazardous substances and preparations |
| VBG 61 | Accident Prevention Regulations "Gases" |
| ZH 1/119 | Guidelines for laboratories |

5 OPERATION

The function of the AK 400 PECVD has been tested. The entire system is operated using a PC and related control software based on MICROSOFT WINDOWS® NT4.0.

Manual operation includes the operation of the master switch, activation of media such as cooling water, compressed air, nitrogen, process gases as well as loading the process chamber.

The software is neither capable of circumventing nor of deactivating the hardware interlock chain with its process master switch and interlock switches (see section 8.3, "Interlock description").

5.1 Start

After turning on the master switch and starting the PC, the software for operating the system may be loaded and run under WINDOWS® NT.

The following conditions have to be met:

- Cooling water stop valves are open
- Compressed air valve is open
- Process gases, venting gases and seal gases have to be available as required

5.2 Software description

See: "User Manual: Software"

5.3 Shutdown

Normally, the vacuum remains in the system after the valves concerned have been closed.

Before the entire system is turned off, e.g. for maintenance work, the recipient has to be vented. To do this, residual gas has to be pumped off after the process for at least 20 minutes, the process master switch has to be deactivated, and then the sequence "Venting" has to be activated in the "Pumping unit" menu. After the recipient has been vented to bring the pressure up to normal (venting valve is closed when switching point is reached at the pressure switch), the system may be turned off. Thereafter, all media have to be turned off.

IMPORTANT

If the system was heated, never turn off the hardware and software system until the heater temperature has dropped below 100 °C.

Failure to vent the recipient involves the risk of vapour flowing back or of residue from rotary pumps to be left over when the system is off.

6 SERVICES

To achieve a high level of availability and productivity for the system, we offer the support services described below:

6.1 Maintenance

Specific maintenance agreements may be concluded with *Roth & Rau Oberflächentechnik AG* to ensure that maintenance and servicing of the system is duly performed at regular intervals as prescribed by the maintenance plan. Such maintenance agreements relate to the system and the components used therein with regard to specific products and applications.

6.2 Spare parts

In case of any necessary repairs, store-managed spare parts will be available at short notice. Instant commissioning enables us to despatch the parts requested on the day when a notification of a defect is received.

To reduce downtime for maintenance and repair as much as possible, we recommend keeping a stock of spare parts, spare part packages and consumables to be managed in accordance with the order. If repairs are carried out by the customer, necessary special tools should be used. A detailed offer for the items required may be provided if desired.

6.3 Repair / Replacement

If a repair becomes necessary, there are the following options:

- Repair is carried out by the customer using spare parts and spare part packages
- Repair is carried out on-site by *Roth & Rau* service mechanics or service mechanics of component manufacturers
- Defective components are replaced
- Components are repaired at the manufacturer's plant

The inspection criteria applicable to new devices also apply to replaced devices and devices repaired at the manufacturer's plant. Performance parameters will be absolutely identical. In case of replacement, a device conforming to the current status of line production will be supplied at all times. As a basic principle, replacement will be made for a defective, though repairable device.

If the customer carries out repair or maintenance of devices which have come into contact with materials that may pose a health hazard, the relevant applicable rules and regulations have to be observed.

The following rules have to be observed for devices sent to us for repair or maintenance:

- Before sending contaminated devices to us, decontaminate them in accordance with radiation protection regulations.
- Provide all devices we receive for repair or maintenance with a clearly visible notation, **"Free from harmful substances"**. Apply the same notation on the bill of delivery and on the cover letter.
- Please use the enclosed "Declaration about contamination".
- The customer may have the devices decontaminated by us (except for devices contaminated by radioactivity). In that case, additions have to be made to the repair order accordingly, and the process gases the device has come into contact with have to be specified. In case of failure to specify them, they will be determined by us, and the costs incurred for this will be charged.

Observe all specific handling regulations.

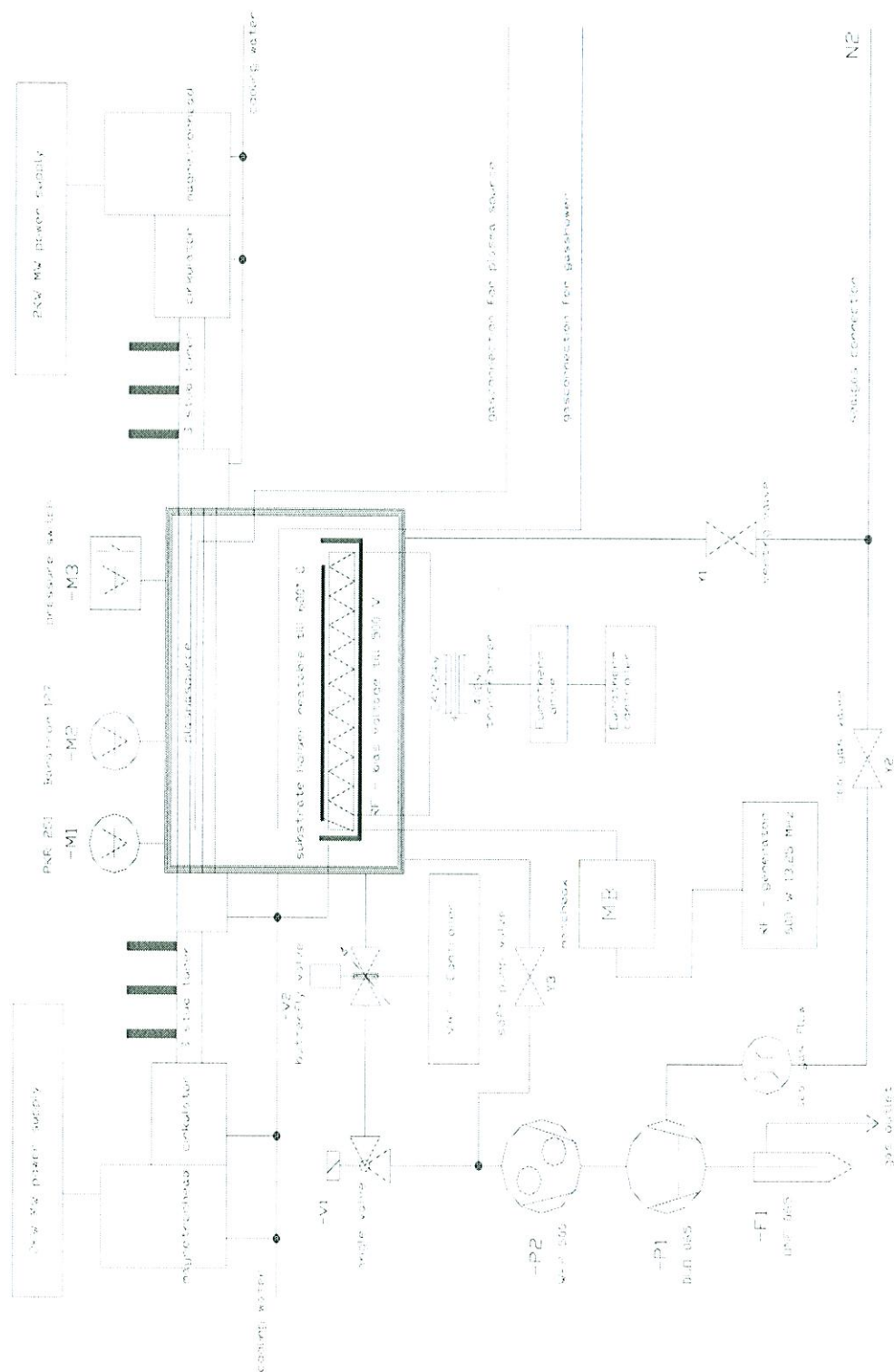
We will carry out a decontamination and charge you for it if you have failed to provide the notation **"Free from harmful substances"** on the device or in its supporting documents.

"Harmful substances" shall be defined as: Materials and preparations pursuant to Council Directive 67/548/EEC of 27 June, 1967, Article 2.

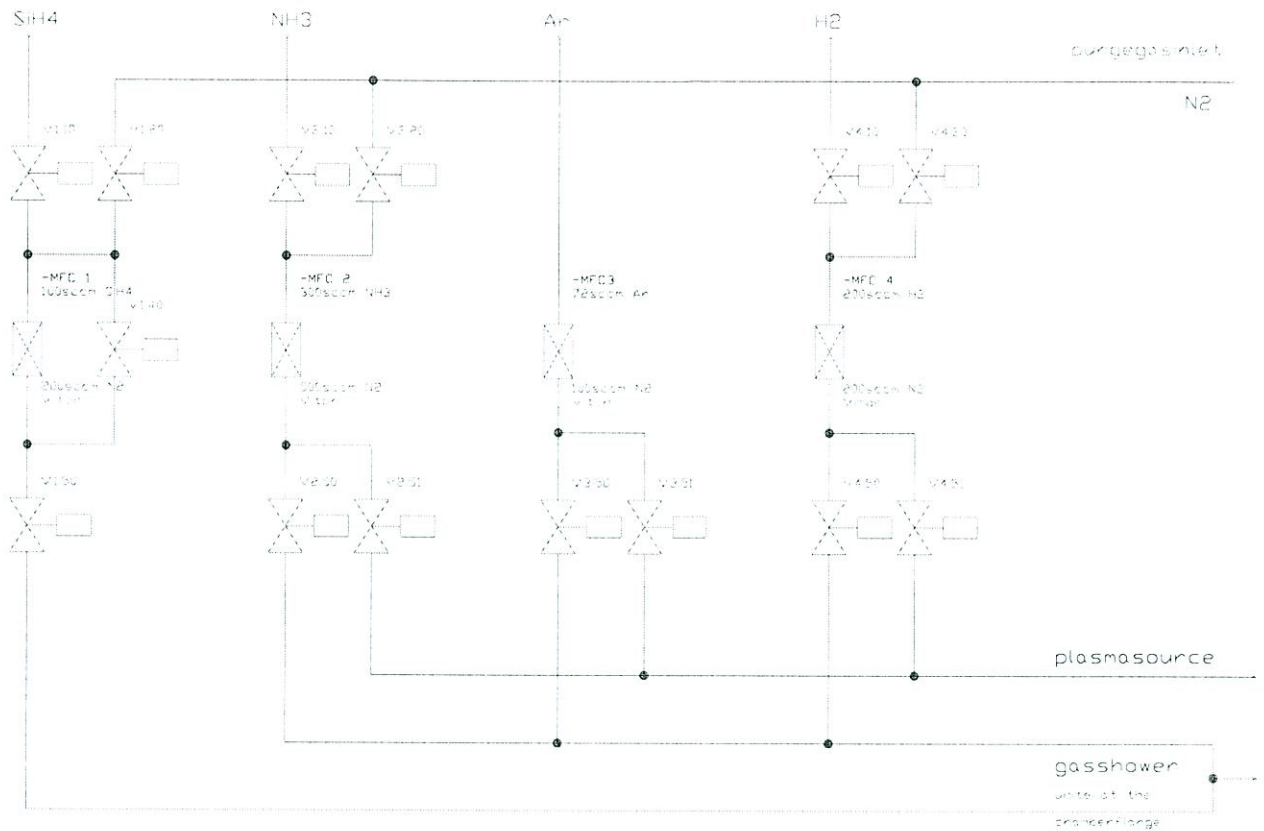
6.4 Training

Special customer training is carried out for the maintenance and repair of the components used. Participation in such courses will enable the customer to repair the devices properly himself. For more detailed information, please contact *Roth & Rau Oberflächentechnik AG*.

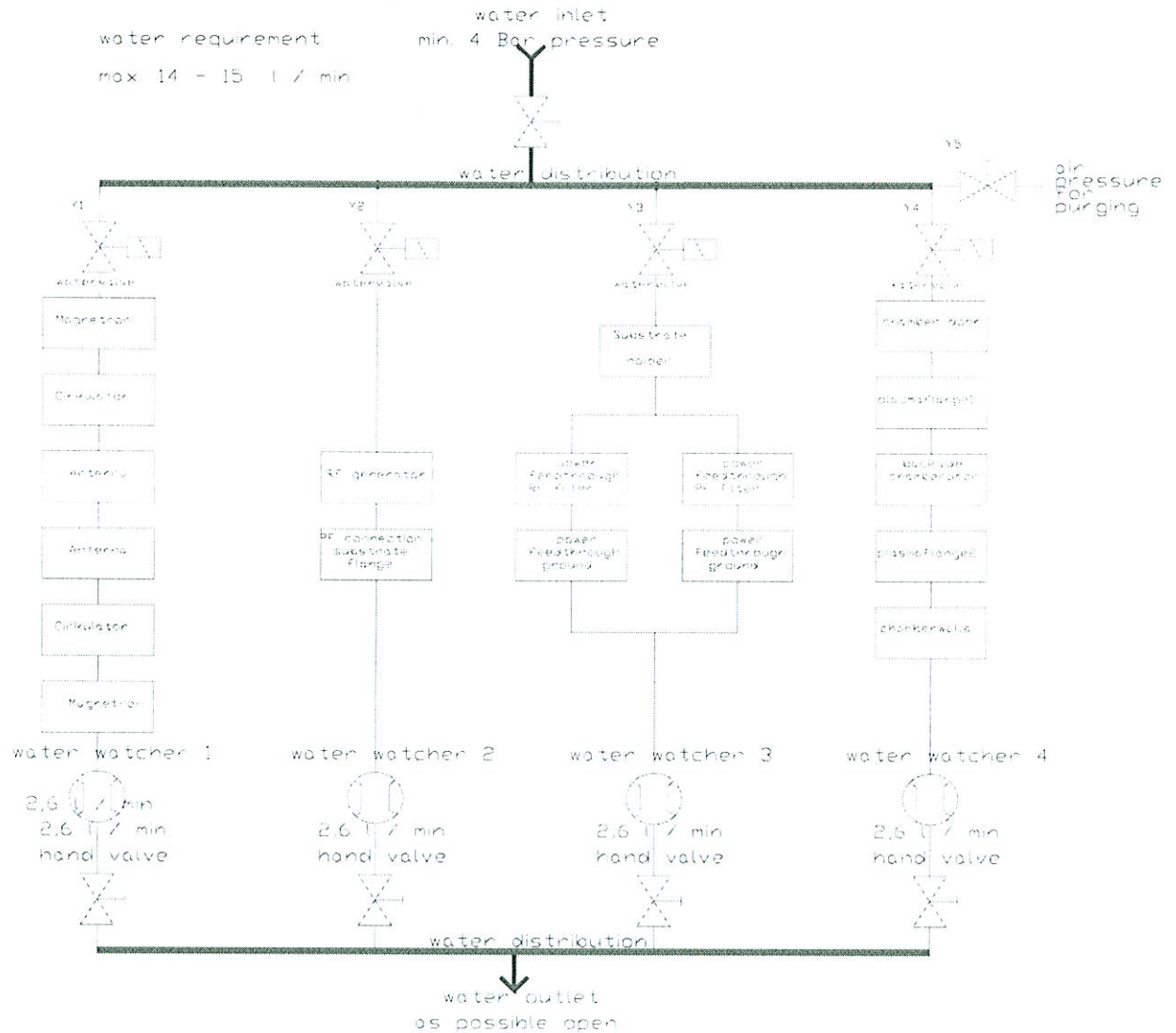
7.1 Diagram of the vacuum system



7.2 Diagram of the gas dosing system



7.3 Diagram of the water system



7.4 Interlock description

7.4.1 Safety of persons and machines

7.4.1.1 Emergency shutdown switch

The purpose of the emergency shutdown switch is to switch off the system master switch and to prevent the master switch from being turned on again.

The emergency shutdown chain consists of the following components:

- Safety relay with emergency shutdown button at the front of the operator cabinet. More emergency shutdown buttons may be connected to the system.

7.4.1.2 Risks posed by the plasma process

System parts necessary for the plasma process are released via a process master switch. They include the following components:

- Heater
- Microwave power supply units
- RF generator
- Valve island for gas supply

Switching on of the process master switch is controlled by the software. The hardware and software will disable operation unless the conditions listed below are met:

- Pumping unit is running
- Angle valve of pumping unit is open
- Door of process chamber is closed (Siguard switching relay active)
- Pressure in process chamber less than 50 mbar

These conditions run together in a safety circuit PNOZ X7 (yellow) at the nodal point.

If one of the conditions is not fulfilled, the process master switch will be switched off. Switching it back on again will not be possible.

7.4.2 Risks posed by gases

Gas valves may only be activated while the process master switch is turned on.

Gas valves may only be opened while:

- the safety circuit (referred to above) is active
- seal gas is flowing, flow meter is active

7.4.3 Heaters

Heaters may only be activated while:

- the process master switch is active (for conditions see above)
- no excess temperature is signalled by Eurotherm 2408
- water cooling of the substrate holder, the process chamber and air cooling of plasma source tubes are temperature-controlled by the software of the system

7.5 Technical data

7.5.1 Dimensions

Rack cabinet (width x front-to-back x height):	600 × 810 × 2130 mm
Recipient system (width x front-to-back x height):	1400 × 1650 × 1500 mm
Pumping system (width x front-to-back x height):	650 x 1000 x 9500 mm

7.5.1.1 Weight

Weight of the complete standard system:	approx. 700 kg
---	----------------

7.5.1.2 Foundation

No special foundation is necessary. The surface load of the complete system is approx. 200 kg/m².

7.5.2 Pumping unit

For information on the suction capacity of individual pumps please refer to the relevant operating instructions.

7.5.3 Connection parameters

7.5.3.1 Electrical system

Power input:	max. 15 kW
Voltage:	{400 +/- 5 %} V (3P\N\PE)
Frequency:	50 Hz
Control voltage:	220 V~/ 24 V-/ 24 V~ (supplied internally)
Measuring voltage:	+/- 15V

7.5.3.2 Pneumatic system

Compressed air:	5 to 6 bar oil-free
Connection:	Festo hose nozzle 6 mm OD

7.5.3.3 Process gas system

Central connection of all gas lines:	4VCR®
--------------------------------------	-------

7.5.3.4 Cold water

Pressure:	4 to 6 bar
Run-off:	unpressurised
Inlet temperature:	max. 25°C
System flow quantity:	approx. 840 l·h ⁻¹
Connection:	½ " nipple (13mm)
Run-off to atmosphere:	½ " nipple (13mm)
Pressure drop p:	up to 4 bar

7.5.3.5 Exhaust gas

Exhaust connection DN 40 KF to rotary pump

7.5.3.6 Ambient temperature

Maximum ambient temperature (outside the system)	30°C
---	------

Make sure that this temperature is not exceeded in the room of installation, even while the boiler heater is active.

7.6 Operating instructions for individual components

Please refer to the documentation's table of contents

Part list Canberra AK400			Project: T23131		Date: 03.03.2006	
Pos.	Description	Type	Distributor	Unit	Order number	Serial number
Process chamber						
1	Process chamber incl. door		Streicher	1	2005-0003442	
2	Viton sealings	for MW-tubes	Druschke	12	diameter 29 x 3,5 FPM 70	
3	Viton sealings	for door and backside	Druschke	2	diameter 574 x 6 FPM 70	
4	Viton sealings	for plasmasource	Druschke	2	diameter 254 x 6 FPM 70	
5	Pump oil for WKP500 and DUO65	F5	Umex	8		
6	Rotary vane pump station with	WOD412BC	Pfeiffer Vacuum	1		
7	Rootspump	WKP500AM	Pfeiffer Vacuum	1		21073823
8	Rotary vane pump	DUO65C	Pfeiffer Vacuum	1		21045264
9	Oil mist filter	ONFR 035/065DC	Pfeiffer Vacuum	1		
10	Full range compact gauge	Ionivac Penning/Bayard/Alpert	Leybold	1	IFR-90-CTR 100 / 230 305	12103-142092 109 *
11	Absolute pressure gauge (Baratron)	672BX	MKS	1	627BX01MCC1B	209425G10
12	Butterfly control valve with stepper motor	DN 100 ISO-F	VAT	1	61144-CE52	001/0017 A629118
13	Pressure controller	PM3	VAT	1	610PM-16AC	0002/0355
14	Connection cable Controller - Butterfly	10 m	VAT	1	610CV-99LJ	
15	Pressure switch	with two setpoints	IFM	1	PN 7009	
16	Connection cable	3 m	IFM	1	E 10902	
17	CF 16 - PN7009 adapter		Vacom / R&R	1		
18	CF 40 - pipe adapter		Vacom / R&R	4		
19	CF 40 blind flange		Vacom	2	F35	
20	CF 16 - gauge adapter		Vacom / R&R	1		
21	CF 63 blind flange		Vacom	1	F63	
22	CF 160 blind flange		Vacom	1	F150	
23	Electrical power feed through	DN 35 CF 600 A	Vacom / R&R	2	CF 35-1-2781-01	
24	RF - filter	feed through filter 100A,2x1y	Tesch	2	02000013	
25	Bypass valve for soft pumping		Flowlink	1	VP EL 212 CF 16 FC6NF	
26	Venting valve		Flowlink	1	MVP 214 MM	
27	Filter for Full range gauge	DN 35 CF - DN 35 CF	R & R	1		
Substrate holder						
1	Substrate electrode complete	HF - bias capable	R&R	1		

*) Austausch Mai 2008

Pos.	Description	Type	Distributor	Unit	Order number	Serial number
	Heater					
1	Transformer for heater	prim.400V / sek. 60V / 120A	Barth	1	ET 400/60V	793804-09
2	Eurotherm controller	2408F	Eurotherm	1	2408F	
3	Eurotherm limiter	TE 10	Eurotherm	1	Limit TE10 A	
4	High current fuse holder		Siemens	2	3NH7 030	
5	Fuse	100A	Siemens	2	3NA7 830	
6	Semiconductor fuse	25 A	Bussman	1		
	Microwave / RF					
1	ECR-Plasma source Duo Plasma Linie		R&R	1	LPS 2.0	01 / 05
2	Microwave coupling tubes	Silux 30x2x600	SICO - Jena	2		
3	Microwave aerial		R&R	2		
4	Short circuit slider		Muegge	2	MW 2009D - 260ED	09/05 & 09/05
5	3 stub tuner		Muegge	2	MW 2009A - 260ED	09/05 & 09/05
6	Magnetron head with circulator	2000 W	Muegge	1	MH 2000S - 215 BB	58206
7	Magnetron head with circulator	2000 W	Muegge	1	MH 2000S - 215 BB	58207
8	Reflection diode		Muegge	2	MM 1001 B	
9	High pressure fan		Herz	1	G63A2	
	6-channel gas dosage system					
1	MFC Profibus, viton, VCR4,24V	200 sccm N2 Viton	MKS	1	1179BX22CR14V	470723G20
2	MFC Profibus, viton, VCR4,24V	500 sccm N2 Neopren	MKS	1	1179BX52CR14N	G470759G20
3	MFC Profibus, viton, VCR4,24V	100 sccm N2 Viton	MKS	1	1179BX12CR14V	470719G20
4	MFC Profibus, viton, VCR4,24V	200 sccm N2 Viton	MKS	1	1179BX22CR14V	470724G20
5	MFC Profibus, viton, VCR4,24V	500 sccm N2 Neopren	MKS	1	1179BX52CR14N	G471907G20
6	MFC Profibus, viton, VCR4,24V	200 sccm N2 Kalrez	MKS	1	1179BX22CR14K	G471908G20
7	Valve terminal CPV 10	CPV 10-VI	Festo	2	CPV10-GE DIO1-8	
8	Pneumatic membrane valve	MM 214 MM NF	Flowlink	23	MM 214 MM NF	
9	Particle filter	4V4TA-F4L-1-SS	HPS	6	4V4TA-F4L-1-SS	

Pos.	Description	Type	Distributor	Unit	Order number	Serial number
	Air pressure & N₂ preparation					
1	Pressure switch		Festo	2	PEV-1/4-SC-OD	
2	Pressure control unit	for air	Festo	1	LFR-1/4 -D-5M-Mini	
3	Pressure distributor		Festo	1	FRM-D-Mini	
4	Hand valve		Festo	1	HE-D-Mini	
5	Magnet valve	6012C 3/2way	Bürkert	2	00134156	
6	Cable box for 6012C		Bürkert	3		
7	Pressure controller for N2	E61/M61	Messer	1	LM61	71705798
	Sealing gas					
1	valve for sealing gas	2/2 way valve 24 VAC	Bürkert	1	134112	
2	flow controller for sealing gas	20 NI / min	Meister Strömungstechnik	3	RVO/U-L40020 G 1/4" MS	
3	pressure reducer	for N2	Festo	1	GRO - 05 - 6	
	process power supply					
1	RF-generator 13,56MHz 600W	PFG 600 RF	Hüttinger	1		200035969
2	Matchbox	PFM 1500 A	Hüttinger	1		200036332
3	HF - cable 2x type N	7,32m RG 214	Hüttinger	1	0465649	
4	MW-power supply 2000 W		Muegge	1	MT 2000D-110HC	62028
5	MW-power supply 2000 W		Muegge	1	MT 2000D-110HC	6202x
6	Cable set		Muegge	2		
	High power blower	for MW tube cooling	Herz	1		
	water cooling					
1	Magnet valve	2 / 2 way positively controlled	Bürkert	4	6213A	
2	Cable plug boxes for valves	28mm, 3-pin	Bürkert	5	00008360	
3	Water watcher	SI 1000	IFM	4	SID10ADBFPKG	
4	Cable plug box for water watcher		IFM	4	E10902	
5	Water distributor		R&R	2		
6	Water hose clamps 3/8		IT S	2		
7	Water hose clamps 1/2		IT S	4		
8	Ball valve		IT S	7		

Pos.	Description	Type	Distributor	Unit	Order number	Serial number
	Controlling					
1	Industrial personal computer	Lintec	ACO -Soft	1		0208 0007
2	TFT monitor	15"	Enna	1	AA1015450205AC	04052213
3	Keyboard with touchpad	PS2 Cherry with Touchpad	ACO -Soft	1		
4	Simatic DP bus connector	153	Siemens	2	6ES7153-1AA03-0XB0	
5	Simatic 16 DI device	321	Siemens	3	6ES7321-1BH02-0AA0	
6	Simatic 16 DO device	322	Siemens	3	6ES7322-1HH01-0AA0	
7	Simatic 8 AI device	331	Siemens	1	6ES7331-7KF02-0AB0	
8	Simatic 4 AO device	322	Siemens	1	6ES7322-5HD01-0AB0	
9	Simatic Connector		Siemens	8	6ES7392-1AJ00-0AA0	
10	Profibus plug		Siemens	10	6ES7972-0BA30-0XA0	
11	Profibus plug with resistor		Siemens	2	6ES7972-0BA41-0XA0	
12	CP 5611 profibus PCI card		Siemens	1	6GK1561-1AA00	
13	CP 5611 licence		Siemens	1	6GK1704-5DW63-3AA0	
14	security door contact	PSEN 1.1	Pilz	1	504210	
15	Cable with angular connector for PSEN 1.1	PSEN KABEL	Pilz	1	533120	
16	Safety relay	PNOZ X7	Pilz	1	774059	
17	Safety relay for emergency-off	PNOZ X2.1	Pilz	2	774306	
18	Automatic circuit breaker	1pin C1	Siemens	1	5SX21 C1	
19	Automatic circuit breaker	1pin C6	Siemens	3	5SX41 C6	
20	Automatic circuit breaker	1pin C10	Siemens	2	5SX21 C10	
21	Automatic circuit breaker	3pin C10	Siemens	2	5SX23 C10	
22	Automatic circuit breaker	3pin C16	Siemens	1	5SX23 C16	
23	Automatic circuit breaker	1pin C16	Siemens	2	5SX21 C16	
24	Automatic circuit breaker	3pin B16	Siemens	1	5SX43 B16	
25	Automatic circuit breaker	2pin C25	Siemens	1	5SX22 C25	
26	Relay 4-pin	24 V DC	Siemens	2	LZX PT5A5L24	
27	Relay 2-pin	24 V DC	Siemens	2	LZX RT424024	
28	Fuse holder for low current fuses		Entelec	12		
29	clamp material		Entelec	50		
30	Power switch	NZMB1-4-A40	Moeller	1	265799	
31	Mounting set	NZM1-XSR-R	Moeller	1	266656	
32	Low voltage actuator	NZM1-XUHV24AC	Moeller	1	259531	
33	Process switch	PKZ2/ZM-32-8	Moeller	1	055081	
34	Motor drive	RS - PKZ 2(220V/50Hz,DC)	Moeller	1	063688	
35	Low voltage actuator	U - PKZ 2(24VDC)	Moeller	1	057454	
36	Auxiliary switch	NHI11-PKZ 2	Moeller	1	090677	
37	Transformer	12VAC+12VAC, 24VA	Siemens	1	4AC3624	

Pos.	Description	Type	Distributor	Unit	Order number	Serial number
38	Transformer SIDAC T	24V AC	Siemens	1	4A40424TN	
39	Power supply unit Sitop Power10	24 V DC	Siemens	1	6EP 1334-1SL12	
40	Protection switch against excess temperature	Simirel	Siemens	2	3RN1011-1CB00	
41	Power contactor	24 V AC / 5,5 KW	Siemens	6	3RT1017-1AB01	
42	Auxiliary contacts		Siemens	2	3RH1911-1HA12	
43	Power contactor	24V DC / 7,5 KW	Siemens	1	3RT1026-1AB00	
44	Auxiliary contacts		Siemens	1	3RH1921-1CA10	
45	Electrical material	miscellaneous	B & P	1		
46	Multiple socket outlet		Rittal	1		
47	Fan for Rittal rack		Rittal	1		
48	Fan controller		Rittal	1		
49	Coupling relay	1-pin	Siemens	6	3TX7004--1LB00	
Software						
1	Runtime licence development studio		AIS	1		
2	Runtime licence interface		AIS	1		
3	Runtime licence licence		AIS	1		
4	Runtime licence automatic object		AIS	1		
Assembly						
1	Rack cabinet	2000x600x800	Rittal	1	8438510	
2	Side walls for electr. cabinet	2000x800	Rittal	1	8108235	
3	Socket front/rear	600x100	Rittal	1	8601600	
4	Socket left/right	100x800	Rittal	1	8601080	
5	Adapter for rack cabinet	19"	Rittal	1	8613010	
6	Slide bars for rack cabinet	for 800mm	Rittal	1	8613180	
7	Electrical cabinet incl. mounting plate	600x600x250	Dessauer Schaltschrank Gm	1	WA0606 2510 1000	
8	Gas cabinet	600x800x300	Dessauer Schaltschrank Gm	1	WA0608 3010 1000	
9	Mounting plate for gas cabinet	ca. 500x700	Werbetechnik Müller	1		
10	Casing panel		Werbetechnik Müller	3		
11	Feets for frame	Arbor M16x100, plate 60mm	AKON	4		
12	Machine frame	stainless steel	Waagenbau GmbH	1		